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DIFFERENCES OF AC AND DC DRIVES OF VARIOUS TRAMCARS MODELS

The article discusses the schematic diagram of the tram KTM-5M3. Moreover, describes comparative description of the technical properties of tram engines. The limitations and advantages of using mixed excitation motors for urban electric transport are shown.

Keywords: tramcar, schematic diagram, current, voltage, current overload, short circuit, engine, trolley.

Introduction

Analysis of the movement of the KTM 71-605 tramcar showed that in traction mode, both groups of engines receive power through a common starting rheostat. During braking, each group of engines operates on a separate brake rheostat.

Starting and acceleration of the car from a stop is carried out by turning on the driver's controller to one of the running positions, as a result of which the starting rheostats are gradually removed from the chains of traction motors, which have serial and parallel excitation together. Then the field of traction motors is weakened by disconnecting the parallel field coils and connecting the field attenuation shunts in parallel to the series field windings. During electrodynamic braking, each group of electric motors is shunted by its own brake rheostat. The excitation of traction motors in this case depends on the parallel excitation winding, which is partially switched on through the brake rheostat, as a result of which an anti-compound braking characteristic is created.

With rheostat braking, which is used as a service, each group of engines operates on its own stages of the brake rheostat, which contributes to a more stable braking mode, since the influence of one group of engines on another is excluded due to the inequality of characteristics and when there is a skid and skidding.

When the voltage disappears in the contact network or the fuse burns out in the parallel windings of traction motors, the electric braking is automatically replaced by braking with independent excitation of the successive windings from the battery and the charging generator of the auxiliary electric circuit.

Research object: urban electric transport.

Subject of the study: technical characteristics of tram engines.

Purpose: identify the most advanced types tram's engines.

Objective: analyze the technical characteristics of tram's engines.

Research methods and results: analysis, description, observation.

The KTM 71-605 car is equipped with an automatic control system. The KB control controller has a zero position, four positions for the start mode and five positions for the braking mode. The first starting position M is used for maneuvering mode-movement at low speed with fully inserted rheostats. In the 2nd position XI of the KB controller, the start is performed with a low acceleration of 0.6 m/s^2. The start ends at the 13th position, where the starting rheostats are removed and the independent excitation winding is disconnected [1].

The position X2 of the driver's controller differs from the position XI in that the car moves with a high acceleration 1.0−1.2 m/s^2. At the position of the driver's controller XS, the car moves with a maximum acceleration of 1.4 −1.5 m/s^2.

At the positions of the rheostat controller, following the 13th position, the increase in the speed of the car occurs when the excitation of the traction engines is weakened, and at the 17th position (the last), the greatest weakening of the excitation is obtained.

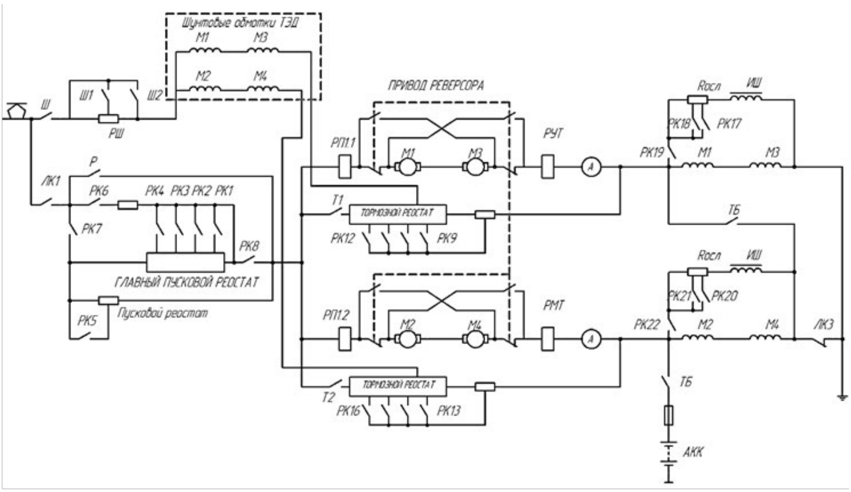

Figure 1 − Schematic diagram of power electric circuits of KTM-5M3 tram traction motors

The study showed that in the first three brake positions T1-T3 of the KD driver controller, non-automatic braking occurs, used to gradually increase the

387

braking force before service braking or to slow down the tramcar on inclines. At the T1 position, the current in the independent excitation winding and the braking force are the lowest.

In the T2 and T3 positions, the excitation current and braking force increase. The T4 position is used for service braking. At this position, the brake rheostats are output under the control of the РУТ acceleration and deceleration (braking) relay, and when the car speed decreases to 3-5 km/h, mechanical braking is applied to the rheostat braking. After setting the driver's controller handle to the TP position, the rail brakes take effect [2].

The KTM 71-608 tramcar is powered via a contact network with a direct current of 550 V and two batteries with a voltage of 24 V.

When starting the tramcar from the place, the starting and braking resistances are included in series with the windings of the electric motors and as the acceleration begins to be output in stages using the rheostat controller. Driving and braking modes are controlled from the driver's cab using a controller.

The KTM 71-608KM tramcars also have an auxiliary control panel located on the rear platform of the passenger compartment. For the operation of the tramcar in the front and rear of the tramcar, plug connectors for high-voltage and low-voltage communication are provided. In the event of a break in the tramcars, the scheme provides a protection system that initiates emergency braking of tramcars. In total, up to three tramcars can be used in the train.

The microprocessor-based automatic control system (MBCS) controls the rectifier-inverter converters, regulates the current of the TAD-21 engine and the speed of the tram.

The power circuits of the KTM 71-623 tramcar are powered from the contact network through a semi-pantograph installed in the front part of the roof. The car uses TAD-21 (4x50) traction asynchronous motors (table 1) with a supply voltage of 400 V, a nominal current frequency of 50 Hz, a nominal synchronous speed of 1500 rpm and a power of 50 kW. The engines are made on a modern element base and provide good energy and dynamic characteristics. The drive of each wheel pair is individual. In the braking mode, it is possible to recover electricity to the contact network [3].

Asynchronous traction motors are used, they have smaller weight and size indicators, are more reliable in operation and are much easier to maintain than DC motors.

Table 1 – Technical characteristics of tram engines

Engine type	ДК-259Г-3	TE 022	TE 023	TE 028A01	ТАД-21	KP252
Power (kW))	50	45	45	103.5	50	50

Number of revolutions (rpm)	1160/4060	1750 /4200	1720/3910	1857/4300	1500/ 4000	1230/ 4060
Rated voltage (V)	275	300	300	300	467	275
Rated current (A)	211	150	175/100	380	76	175
Excitation	mixed	serials	serials	serials	—	independent
Insulation class	F	B	F	F	H	H
The weight of the unit	450 kg	320 kg	287 kg	530 kg	350 kg	465 kg

Direct current from the contact network with a voltage of 550 V is converted to alternating current of regulated voltage and frequency using traction inverters before being applied to electric motors, which receive control signals from the driver's cab from the microprocessor control system (MPCS).

The control circuits and auxiliary equipment are powered by batteries and a static voltage Converter БП-3Г DC 24 V (48 V) and AC 380/220 V with a frequency of 150–400 Hz.

The battery provides for some time the operation of the heating and lighting systems in the cabin in the absence of power from the contact network, and also allows the tram to move at a minimum speed in emergency mode for the possibility of entering the contact network in the event of a stop in the current-sharing zone [4].

Tatra RT6N1 is a six-axle three-section articulated tram for one-way traffic with 63 % low floor, equipped with a thyristor control system. The extreme bogies are motor bogies, the Central bogie is a support one with a parking disc brake.

The Tatra T6B5 tram has two motor trolleys designed for use on tracks with a gauge of 1524 mm. Each trolley is equipped with two traction motors (figure 2, a).

а) б)

Figure 2 – Tatra RT6N1 (a), Tatra 3 (b) tram trolley equipped with a mechanical brake on the engine shaft and a rail electromagnetic brake

Each trolley has two TE-023 DC electric motors with their own ventilation. The motors are connected in series, and each group of motors is controlled by its own Converter. Engine power 45 kW. Accordingly, the total capacity of the tram is 180 kW.

The power circuit diagram of the Tatra T3 wagon contains four TE – 022 traction motors of sequential excitation, connected in series by two in a group, and both groups are connected to each other in parallel. Starting (and braking) rheostats are included in the accelerator device. Additionally, there are rheostats that are activated at the very initial moment of starting the car (starting damper rheostats).

Contactors and relays enable and disable various circuits when the car is running. The linear or main contactor turns on and off the current of the power circuit, and the maximum current relay is used to protect traction motors and power equipment from overload currents and short circuits. Inductive shunts serve to increase the speed of the car (the speed of rotation of the traction engine anchors) when the starting rheostats are withdrawn by weakening the excitation of the main poles of the engines[5–7].

Tatras T4, T6B5 are equipped with a thyristor-pulse control system for traction motors. In comparison with outdated РВЗ with rheostat-contactor СУ Tatras save a lot of energy and provide smoother acceleration and braking.

Conclusions

Some restrictions on the use of mixed-excitation engines used on trams are due to the fact that during regenerative braking there is not always a consumer of electricity on the line, there is a need to equip traction substations with devices for absorbing the recovered energy in a special rheostat or for supplying it to the AC network.

The specific power consumption of T-2 and T-3 cars with sequential excitation engines is about 200 W/t·km, while on KTM-5M3 cars with mixed excitation engines, this power consumption is almost twice less.

Due to a number of advantages of mixed excitation engines Ust-Katav tramcar building plant named after S. M. Kirov installs DC motors with mixed excitation.

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Трамвай модельдерінің айнымалы және тұрақты ток жетектерінің айырмашылықтары

Торайғыров университеті,
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Отличия приводов постоянного и переменного тока различных моделей трамваев

Торайгыров университет,
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Мақалада КТМ-5М3 трамвайының схемалық схемасы талқыланады. Сонымен қатар, трамвай қозғалтқыштарының техникалық қасиеттерінің салыстырмалы сипаттамасын сипаттайды. Қалалық электр көлігі үшін аралас қоздыру қозғалтқыштарын пайдаланудың шектеулері мен артықшылықтары көрсетілген.

Кілтті сөздер: трамвай, схемалық диаграмма, ток, кернеу, шамадан тыс жүктелу, қысқа тұйықталу, қозғалтқыш, троллей.

В статье рассматривается принципиальная схема трамвая КТМ-5М3. Кроме того, приводится сравнительное описание технических характеристик двигателей трамвая. Показаны ограничения и преимущества использования двигателей смешанного возбуждения для городского электротранспорта.

Ключевые слова: трамвай, принципиальная схема, ток, напряжение, токовая перегрузка, короткое замыкание, двигатель, троллей.

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